ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *Luna Innovations FiberPro 2* at our website: ***Click HERE***

LUNA INNOVATIONS

FiberPro 2

User's Manual

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

FiberPro 2 User's Guide
Document version 2.12
© 2004
Luna Innovations, Inc.
2851 Commerce Street SE
Blacksburg, VA 24060
Phone: 540-552-5128
FAX: 540-951-0760
E-mail: solutions@lunainnovations.com
Web: www.lunainnovations.com

No portion of this publication may be reproduced or transmitted by any means without the written permission of Luna Innovations, Inc.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1 Introduction

Overview of the FiberPro 2 2
Theory of Operation and EFPI Sensor 2
Long Period Grating Sensor 4
Fiber Bragg Grating Sensor 5

2 Installation and Setup

Initial Inspection and Contents 7
Standard Components 7
Optional Fiber Optic Sensors 7
System Setup 8
FiberPro 2 Front and Rear Panels 9
User Interface Software Installation 11

3 Connecting Sensors

Front Panel Sensor Connector 13
Fiber Optic Connectors 14
Connector Components 14
Notes About Interconnect Care 15
Connecting a Sensor to the FiberPro 2 16
Damage Prevention for Fiber Optic Connectors and Adapters 17
Interconnect Cleaning 18
Cleaning the Bulkhead Adapter 19
Cleaning the FC Connectors 20

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Final Note on Fiber Optic Interconnects **21**

4 User Interface Software

Instrument Configuration **24**

Configuring the Source and A/D Converter 27

Analog Output Configuration 31

User Interface Screen **33**

Selecting an Output File for Processing 35

Selecting a Spectrum Log File 36

Decimating the Data and Selecting Sampling Duration 36

Sensor Configuration and Database Administration **38**

Sensor Configuration 38

Adding a New Sensor 39

Configuring a Sensor 41

Selecting a Sensor from the Database 42

Detaching a Sensor 43

Saving the Sensor Database 43

Sensor Database Administration 44

Managing Database Files 44

Managing Sensor Definitions 46

Sensor Algorithm Configuration **47**

EFPI Algorithm Configuration 48

Algorithm Configuration for Best Accuracy 48

FBG Algorithm Configuration 50

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

LPG Algorithm Configuration 53
Obtaining the Software Version 53
Setting the Graph Window Options 54
Acquiring Data 55
Reviewing Output Data 59
Viewing an ASCII Output File 62
Reviewing Spectrum Data 63
Viewing a Spectra Log 63
Manipulating the Spectrum Plot 64
Processing a Spectrum Log 65
Hardware Simulation Mode 66
Exiting the Software 68

5 MUX8 Channel Expansion Module

MUX8 Front and Rear Panels 71
Installation and Setup 72
Connecting Sensors 74
Software Configuration for Multiple Sensors 74
Sensor Configuration 75
Power, Gain, and Offset Configuration 76
Algorithm Configuration 77
Data Acquisition, Output, and Review 78
Analog Output 79

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6 Technical Support

General Information **81**

Warranty 81

Special Agreements 82

Documentation Discrepancies 82

Repair Return Procedure **83**

7 Specifications

Instrument and Processor Specifications **85**

A Sensor-Specific Algorithm Configuration Submenus

EFPI Absolute Gap Sensor **87**

EFPI Pressure Sensor **88**

EFPI Relative Gap Sensor **89**

EFPI Strain Sensor **90**

EFPI Temperature Sensor **91**

FBG Strain Sensor **92**

FBG Temperature Sensor **93**

Generic FBG Sensor **94**

LPG Generic Sensor **95**

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Introduction

1



Congratulations! You have purchased a FiberPro 2 fiber optic sensor system from Luna Innovations, Incorporated. The leading-edge fiber optic technology used in the FiberPro 2 allows users to make temperature, pressure, and strain measurements in environments never before approachable with electrical-based gages. Luna Innovations' fiber optic sensors are immune to electro-magnetic interference, intrinsically safe, small, lightweight, and robust enough to handle the most demanding applications.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Overview of the FiberPro 2

1

The FiberPro 2 is a fiber optic sensing system and signal-conditioning unit. It is dedicated to fast, high-resolution operation of Luna Innovations' Extrinsic Fabry-Perot Interferometer (EFPI), Long Period Grating (LPG), and Fiber Bragg Grating (FBG) fiber optic sensors. Optical fiber-based sensors are ideal for making strain, displacement, temperature, pressure, and chemical/biological measurements in a variety of harsh environments. Optical fiber sensors offer many advantages over traditional gages including small size, flexible geometry, high temperature resistance, high elastic modulus, spark resistance, immunity to electromagnetic interference, resistance to attack by most chemical and biological agents, and inexpensive operation.

Theory of Operation and EFPI Sensor

The EFPI sensor head and a block diagram of the FiberPro 2 are shown in Figure 1. The FiberPro 2 fiber optic sensor system employs a broadband light-emitting diode (LED) as the optical source. Light is launched into the input/output optical fiber to the sensor head where it is modified by the Fabry-Perot cavity inside the EFPI sensor. The light travels back from the sensor head to the FiberPro 2 system where the spectral properties of the light are monitored. A complex signal processing algorithm is then used to calculate the EFPI air cavity length, *s*, from the optical signal returned by the EFPI sensor head. With the appropriate EFPI sensor and associated calibration factors provided by Luna Innovations, strain, temperature, pressure, and many other measurements may be performed using the FiberPro 2. The FiberPro 2 offers multiple measurement modes including Strain, Absolute Gap (Displacement, s), Relative Gap (Change in Displacement, Δs), Absolute Pressure, Differential Pressure, and Temperature.

Note on Strain: Any strain occurring over the gage length of the EFPI strain gage will cause a change in size of the EFPI air cavity length, s. *By dividing the change in* s *by the gage length, strain is calculated. Refer to Luna Innovations Application Note "EFPI Techniques for Strain and Displacement Sensing" for additional information. Contact a Luna Innovations Applications Engineer at support@lunainnovations.com, Voice: 540-552-5128, or FAX: 540-951-0760 for a list of available Luna Innovations Application Notes.*

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

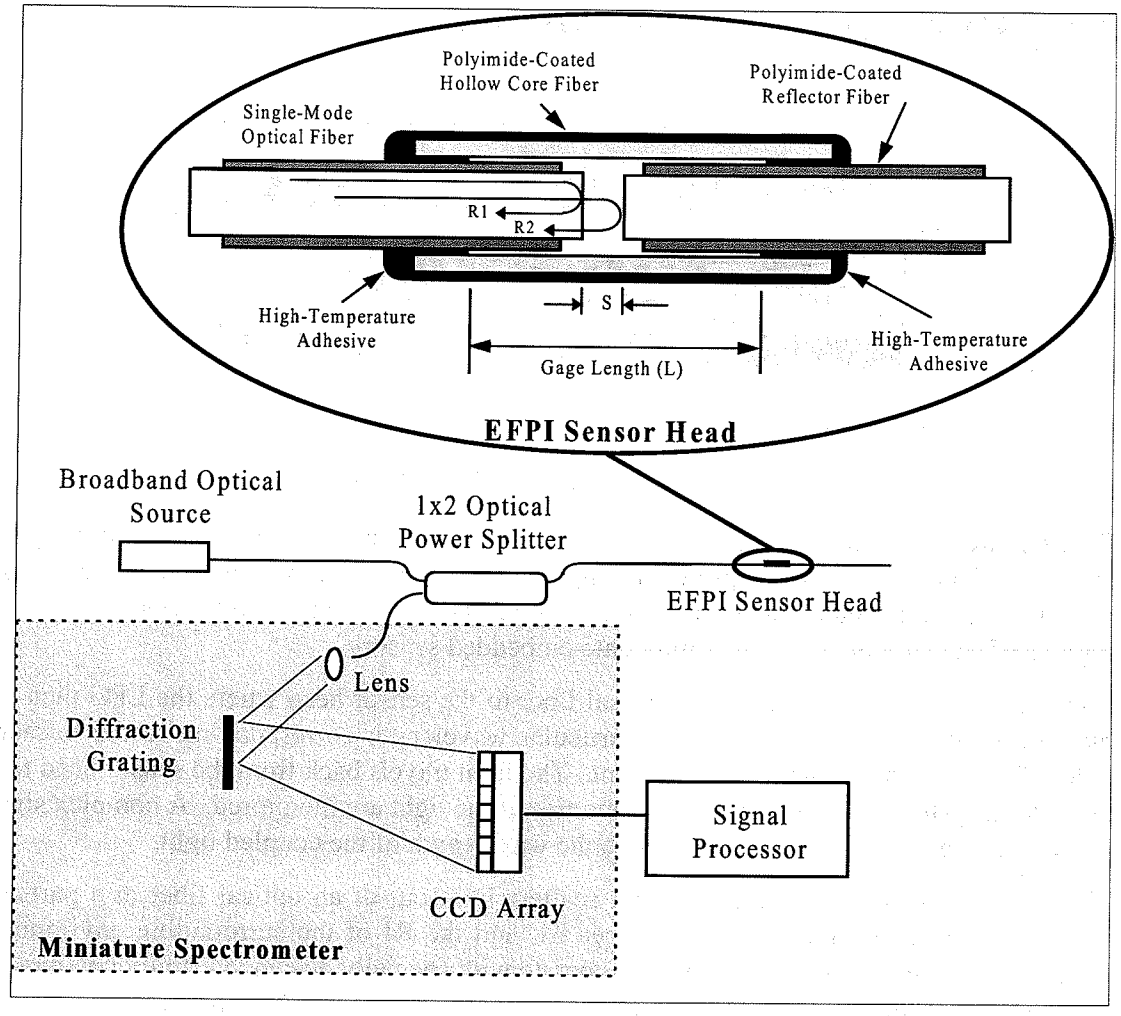


Figure 1. Block diagram of the FiberPro 2 System.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Long Period Grating Sensor

1

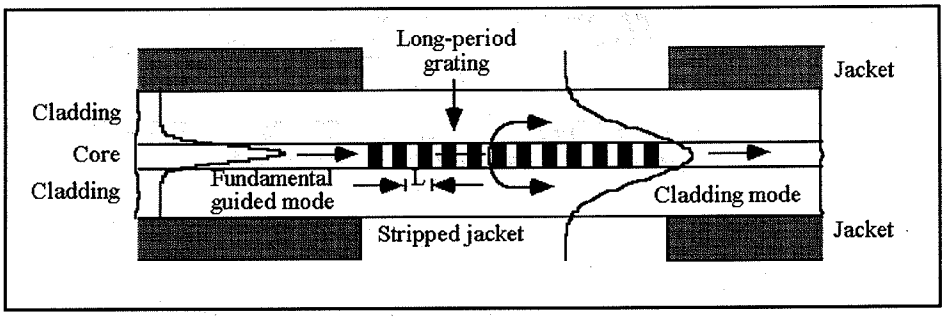


Figure 2. Diagram of the LPG Sensor.

Figure 2 provides a diagram of an optical fiber LPG and how it interacts with light propagating in the fiber. With the appropriate coating, the LPG sensor is designed to identify a variety of environmental targets, such as moisture, pH, and metal-ions in otherwise inaccessible regions of any structures that accommodate embedded sensors.

Light is sent down the input/output optical fiber to the sensor head where the LPG then couples the light out of the grating at a particular wavelength corresponding to the refractive index (RI) of the surrounding environment. The light travels back from the sensor head to the FiberPro 2 system where the spectral properties of the light are monitored. A complex signal-processing algorithm is used to determine the wavelength of the coupled light.

The LPG is a spectral-loss element that scatters light out of an optical fiber at a particular wavelength based on grating period, fiber RI, and the RI of the surrounding environment. LPG-based, biological/chemical sensors operate with specially designed affinity coatings that cause selective, quantitative changes in the RI 'seen' by the LPG in the presence of target molecules. As the coating absorbs target molecules, the RI changes, causing a shift in the wavelength of the scattered light. This wavelength change is demodulated to determine target concentration, enabling real-time monitoring of environmental conditions.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Fiber Bragg Grating Sensor

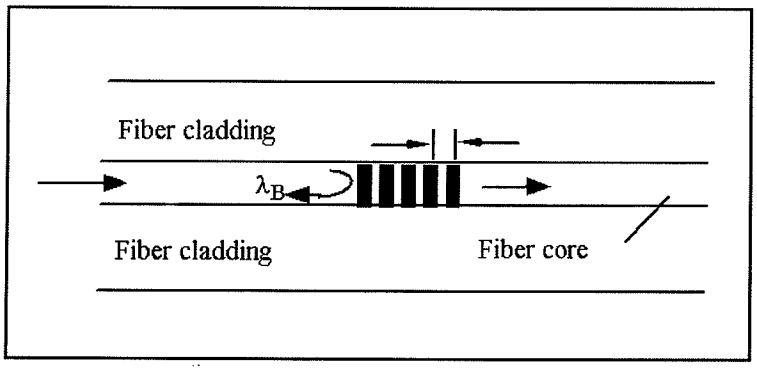


Figure 3. Diagram of the FBG Sensor.

Like the EFPI and LPG sensors, the FBG sensor has many advantages over conventional strain gage sensors. Fiber Bragg gratings are formed in the core of an optical fiber by using the photo refractive effect to produce refractive index changes in the optical fiber.

When light is launched into the optical fiber from the LED source of the FiberPro 2, part of the light incident on the grating is reflected back, while most of the light is transmitted. Figure 3, which shows a diagram of the FBG sensor, illustrates the refractive index variation within the optical fiber core. Under strain, the spectrum of the FBG sensor shows a spectral shift that correlates to strain. The FiberPro 2 analyzes spectral shift from the FBG sensor to make strain and temperature measurements.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

This page has been intentionally left blank

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Installation and Setup

Initial Inspection and Contents

2

Luna Innovations recommends that the FiberPro 2 system and all other materials in the shipping container be thoroughly inspected for damage immediately upon receipt of the delivery. All contents in the shipping container should be compared to the packing slip. Luna Innovations cannot assume responsibility for any shipping damages or material shortages that are not promptly reported by the purchaser. If the shipment is damaged or a product shortage exists, please contact Luna Innovations Customer Service immediately at 540-552-5128.

Standard Components

All FiberPro 2 systems are shipped with the standard components listed below.

- FiberPro 2 instrument
- Instrument power cable
- USB interface cable
- User Interface Software CD-ROM (Windows® XP®)
- User's Manual
- Fiber optic connector cleaning kit

Luna Innovations offers the optional components listed below as add-ons to the FiberPro 2.

Optional Fiber Optic Sensors

- Application-specific sensor (EFPI, LPG, or FBG)
- Sensor configuration parameters

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2 System Setup

After removing the FiberPro 2 instrument and all components from the shipping containers and verifying that no components are missing, follow the steps below for assembling the FiberPro 2 system and any optional components purchased. Luna Innovations recommends that the shipping containers be kept in the event that the instrument should need to be shipped to another location or returned for repairs.

Figure 4 shows the front panel of the FiberPro 2, and Figure 5 shows the rear panel. All indicator lights are located on the front panel, and all power and interface connections are located on the rear panel.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

FiberPro 2 Front and Rear Panels

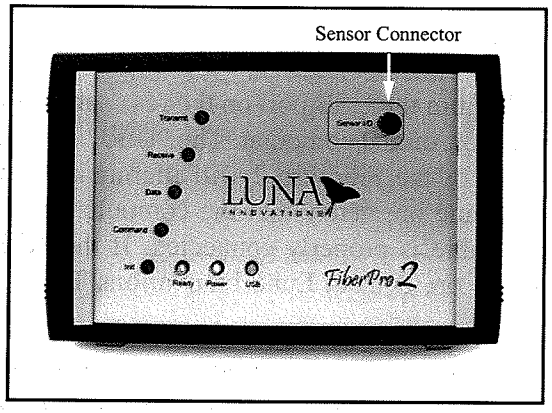


Figure 4. FiberPro 2 Front Panel.

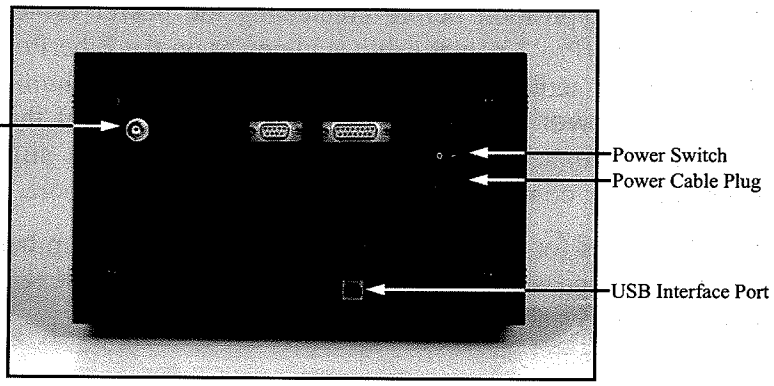


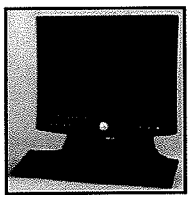
Figure 5. FiberPro 2 Rear Panel.

Notes:

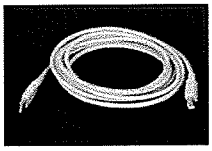
Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2

1. Setup the user supplied computer as per Manufacturers Instruction. Please refer to the Specifications section, page 87 for CPU requirements

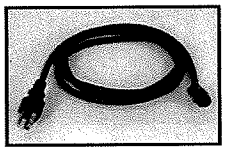


2. Connect the USB cable from the USB port on the rear panel of the FiberPro 2 to the USB port on the computer. The "USB" indicator LED on the front panel of the FiberPro 2 will illuminate. If the "USB" light does not come on, verify that the computer is powered on and the USB cable is properly connected. If the "USB" light still does not come on, contact Luna Innovations Technical Support.



Note: The "USB" indicator LED is powered by the computer via the USB port, and will remain on even when the instrument is not powered on. Because the instrument uses a USB interface port, the FiberPro 2 may be connected to or disconnected from the computer at any time without shutting down the computer or the instrument.

3. Verify that the power switch on the rear panel of the FiberPro 2 is in the OFF, "0", position before connecting the power cable. Connect the FiberPro 2 power cable, and power on the FiberPro 2. The "Power" indicator LED on the front panel will illuminate. If the "Power" light does not come on, verify that the power cable is connected properly. If the "Power" light still does not come on, contact Luna Innovations Technical Support.



4. Allow 30 minutes for the FiberPro 2 instrument to warm-up before using the instrument to perform measurements. This time is required for the temperature of the internal components to stabilize.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Once the FiberPro 2 instrument and computer are properly assembled and powered, the "USB" indicator LED is illuminated, and the software is installed, the "Ready" indicator LED on the front panel of the FiberPro 2 will illuminate. The "Ready" light and the five green indicator lights on the front panel, ("Transmit", "Receive", "Data", "Command", and "Init"), will blink twice simultaneously. Each green indicator light will blink individually from top to bottom, then from bottom to top. When the green lights stop blinking and the "Ready" light comes back on, the FiberPro 2 instrument is ready to use. If the "Ready" light does not come on, verify that the instrument is powered on, the computer is powered on, the USB cable is properly connected, and the software is installed. If the "Ready" light still does not come on, contact Luna Innovations Technical Support.

User Interface Software Installation

The User Interface Software will need to be installed on the user-supplied computer. To install the User Interface Software, simply insert the User Interface Software CD-ROM into the computer's CD-ROM drive, and the install program should run automatically. If the install program does not run automatically, execute the file **Setup.exe** on the CD-ROM and run the install program manually. Follow the instructions on the screen to complete the installation.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

This page has been intentionally left blank

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Connecting Sensors

Once the FiberPro 2 instrument and computer are powered on and ready, the next step is to connect the proper sensor to the front panel of the instrument. Three types of sensors may be used with the FiberPro 2: EFPI, LPG, and FBG.

3

Front Panel Sensor Connector

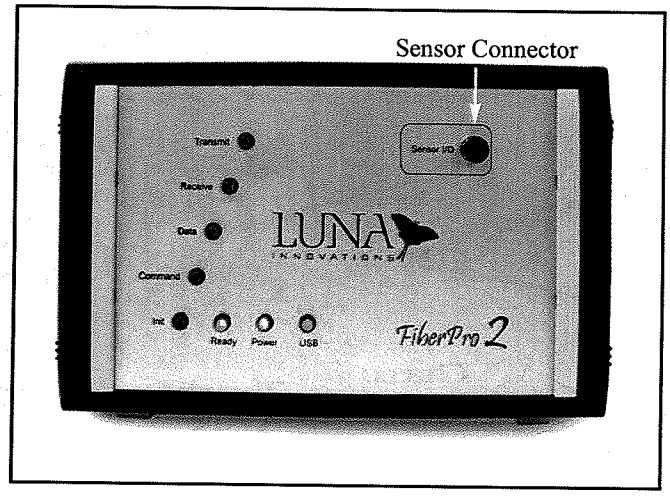


Figure 6. FiberPro 2 Front Panel Sensor Connector

The FiberPro 2 sensor connector accepts only PC/FC connectors. Any sensor used must have this type of connector. Figure 6 shows the location of the sensor connector on the front panel of the FiberPro 2. The following Sections contain detailed instructions for connecting sensors and connector care.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Fiber Optic Connectors

Although the FiberPro 2 system offers many advantages over its electrical counterparts, the FiberPro 2 does require some minimum operational and maintenance practices which will be unfamiliar to users of electrical-based strain gage systems. These operational and maintenance practices revolve around the external fiber optic interconnects on the instrument and the sensors and are explained in this chapter.

3

Luna Innovations uses FC fiber optic connectors for the FiberPro 2. FC connectors are highly robust, very stable, and provide tight-tolerance alignment when mated with another FC connector. Two FC connectors are interconnected using a bulkhead adapter that aligns the optical fibers in both FC connectors (system and sensor). Figure 7 shows an FC connector (left) and a bulkhead adapter (right).

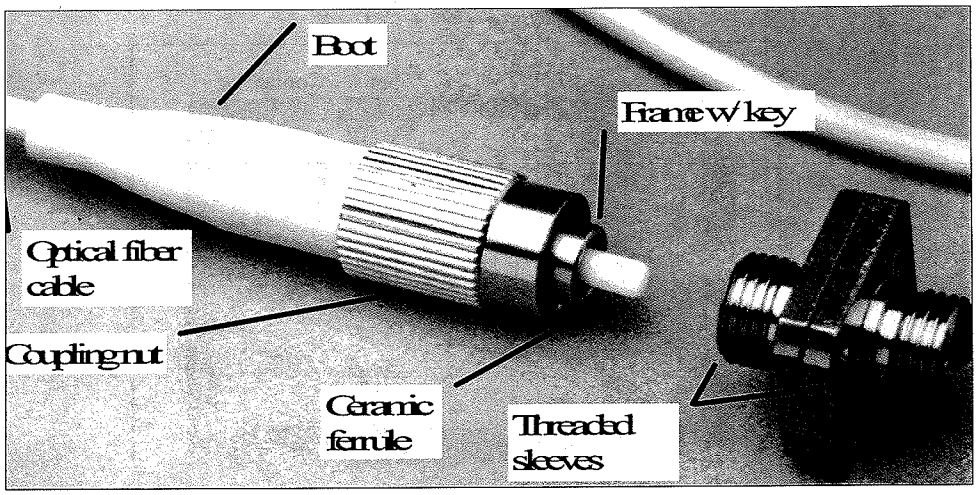


Figure 7. FC Fiber Optic Connector and Bulkhead Adapter.

Connector Components

Below is a brief description of important components in an FC fiber optic interconnect, as labeled in Figure 7.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Ceramic Ferrule: The ferrule is the small ceramic cylinder that houses the optical fiber. The optical fiber passes through the center of the ferrule, and the end of the optical fiber is flush with the end of the ferrule. Since the optical fiber is only 126 micrometers, or about 5 mils in diameter, it is barely perceptible by the human eye. The most critical part of FiberPro 2 system maintenance is to keep the end of the ferrule clean.

Frame with Key: The frame has a tight tolerance fit with the threaded sleeves of the bulkhead adapter. On the frame is a small key, or raised area, which aligns the frame with the threaded sleeve of the bulkhead adapter.

Coupling Nut: The coupling nut is a spring-loaded sleeve that is screwed onto the threaded sleeves of the bulkhead adapter.

Threaded Sleeve: Threaded sleeves are located on both sides of a bulkhead adapter. The coupling nut of each FC connector is screwed onto the threaded sleeves of the bulkhead adapter.

Boot: The boot provides added support to the optical fiber cable that exits the back of the FC connector by limiting the bend radius of the cable.

Optical Fiber Cable: Exiting the back of the FC connector is the optical fiber cable. The strength member of the optical fiber cable (typically multiple strands of Kevlar®) is physically connected to the connector housing and, therefore, provides a high-degree of axial strain relief (prevents the cable from pulling out of the boot). However, always handle connectors with care.

Notes About Interconnect Care

All compatible fiber optic sensors purchased from Luna Innovations come with an FC connector.

NOTE: ALWAYS KEEP THE RUBBER COVERS ON THE FC CONNECTORS AND BULKHEAD ADAPTERS WHEN THEY ARE NOT MATED.

Improper care of the FC connectors can render the FiberPro 2 system inoperable, and will, at the least, degrade the performance of the system. The connectors and bulkhead adapters must be kept very clean, and the FC connectors must be protected from impacts.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

WARNING: NEGLIGENT CARE OF THE FC CONNECTORS WILL VOID THE SYSTEM WARRANTY.

Connecting a Sensor to the FiberPro 2

3

Below is a step-by-step guide on how to properly connect a sensor to the FiberPro 2 system. Although some connectors may look slightly different than those shown in Figure 7 at the beginning of this chapter, they will work the same.

1. Remove the protective covers from the bulkhead adapter and the FC connector.

   DO NOT DISCARD THE PROTECTIVE COVERS. The covers must be reused when the sensor is disconnected from the FiberPro 2. Luna Innovations recommends that the covers be stored in a plastic bag to keep them dust-free while not in use.

   The first step in connecting a sensor to the FiberPro 2 is to remove the covers from the sensor cable and from the bulkhead adapter. Once the covers are removed, the FC connector and the bulkhead adapter should be cleaned.

2. Clean the FC connector.

   Always clean the ceramic ferrule on the FC connector prior to completing the connections process. Follow the instructions in the Section "Cleaning the FC Connectors" on page 20. If the ceramic ferrule comes in contact with any surface prior to being inserted into the FiberPro 2 bulkhead adapter, repeat the cleaning process.

3. Clean the bulkhead adapter.

   Always clean the bulkhead adapter before connecting a sensor to the adapter. Follow the instructions in the Section "Cleaning the Bulkhead Adapter" on page 19.

4. Mate the FC connector with the bulkhead adapter.

   Upon removing the cover from the bulkhead adapter, a small notch should be visible on the exposed threaded sleeve of the adapter. Carefully align the frame key of the FC connector with the slot in the threaded sleeve of the bulkhead adapter. Insert the frame of the FC connector into the bulkhead adapter.

5. Screw the coupling nut to the threaded sleeve.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Gently push the spring-loaded coupling nut towards the threaded sleeve, and screw the coupling nut of the FC connector onto the threaded sleeve of the bulkhead adapter. Screw the coupling nut snugly onto the threaded sleeve, then back off one quarter of a turn to avoid over tightening the connector.

If the threads of the coupling nut do not 'grab' the threads of the threaded sleeve, it is likely that the frame key on the FC connector is not properly situated in the notch on the threaded sleeve of the bulkhead adapter. If this is the case, pull the ceramic ferrule back out of the bulkhead adapter and repeat Step 4.

If the coupling nut is 'grabbing' the threaded sleeve, but is difficult to turn, either cross-threading or a damaged thread may be the cause. Gently unscrew the coupling nut and repeat Step 4. If Step 4 and Step 5 are repeated without success, call Luna Innovations Technical Support.

6. Disconnecting a sensor from the FiberPro 2.

   When disconnecting a sensor from the FiberPro 2, care should be taken to minimize the dust and dirt introduced to the connector and adapter. To disconnect a sensor from the FiberPro 2, first unscrew the coupling nut from the bulkhead adapter. Gently slip the ceramic ferrule out of the bulkhead adapter and promptly replace the rubber covers on the bulkhead adapter and the FC connector.

Damage Prevention for Fiber Optic Connectors and Adapters

The most fragile part of an FC connector is the end of the ceramic ferrule, because the end of the optical fiber is exposed here. However, damage to the connector or adapter can occur in a variety of ways. Some of the ways in which the performance of a connector and/or adapter can be compromised are listed below.

- Dirt on the end of the ceramic ferrule can seriously degrade the FiberPro 2 system performance, or render the entire channel inoperable. Dirt can be removed using the procedures in the Section "Interconnect Cleaning" on page 18.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- An impact to the end of the ceramic ferrule can shatter the optical fiber inside the ferrule, and prevent the optical sensor signal from passing through the connection.
- Using improper materials to clean the end of the connector (such as a finger, a shirtsleeve, or anything abrasive) can scratch the end face of the optical fiber in the ceramic ferrule, and also prevent the optical sensor signal from passing through the connection. Connectors on the sensors and the FiberPro 2 system are carefully polished and cleaned prior to shipping, and should not require cleaning prior to use.
- Epoxy is used to hold the optical fiber in the ceramic ferrule. If the connector is exposed to any solvents, the solvent may soften the epoxy, and the connector may be permanently damaged.
- Due to coefficient of thermal expansion mismatches, the connectors and adapters are rated from -40°C to 80°C. Exposing the connector or adapter to temperatures outside this range may permanently damage them.
- Crushing forces could compromise the tight tolerances of the connector or adapter, and frustrate or prevent mating with other parts.

If the FiberPro 2 system or sensors are returned to Luna Innovations as a result of the previously listed connector damages, the customer will be responsible for all applicable repair, replacement, and shipping charges.

Interconnect Cleaning

Before connecting a sensor to the FiberPro 2, always clean the connector and the adapter. Luna Innovations will provide a connector cleaning kit similar to the one shown in Figure 8. The user will also need a cleaning swab similar to the one shown in Figure 9 to clean the bulkhead adapter.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

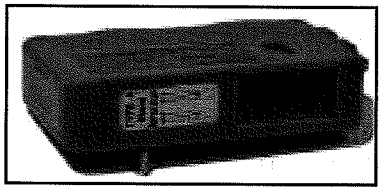


Figure 8. Typical Fiber Optic Connector Cleaner Kit.



Figure 9. Bulkhead Adapter Cleaning Swab.

Cleaning the Bulkhead Adapter

1. Remove the protective cover from the end of the bulkhead adapter, and store the cover in a safe place.
2. Using a new cleaning swab, push the swab completely into the bulkhead adapter, twist the swab, and remove it.
3. Never use a swab more than once.
4. Immediately proceed to clean and mate the FC connector with the adapter to keep exposure to the environment to a minimum.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Cleaning the FC Connectors

1. Remove the protective cover from the end of the connector, and store the cover in a safe place.
2. Hold the connector cleaner with the cleaning strips up, (a). Open the strip cover to expose the strip of cleaning cloth, (b).

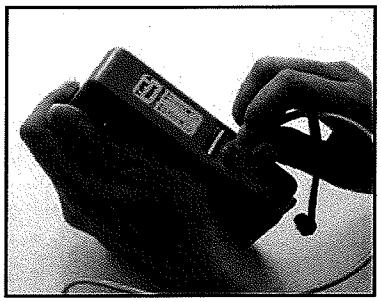


(a)



(b)

3. Rub the tip of the ceramic ferrule on the connector down one side of the cleaning strip, (c), and then down the other side, (d).



(c)



(d)

Figure 10. Using the Fiber Optic Connector Cleaning Kit.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4. Immediately mate the connector to keep exposure of the ceramic ferrule to the environment to a minimum.

Final Note on Fiber Optic Interconnects

Optical fiber interconnects are one of the most challenging aspects of using fiber optic sensor technology. Most of the problems associated with fiber optic connectors arise because they are aligning two optical fibers with tolerances of only micrometers. Although all materials expand and contract with temperature, a fiber optic connector is designed to handle temperature changes while maintaining good alignment of the optical fibers.

As a result of the enormous demands placed on fiber optic connector performance, dirt or poor handling can seriously degrade the performance of the connector. Keeping the connectors clean and protected is the best way to reduce the chance of problems when using the FiberPro 2 instrument. Adhering to the following three simple instructions will provide the best protection for fiber optic connectors:

- Never touch the fiber end face on the ceramic ferrule of the connector.
- When not in use, connectors and adapters should be capped with a protective cover to prevent damage from impacts and to protect them from dust.
- Always clean connectors and adapters before every use.

To maximize your satisfaction with the FiberPro 2 system and fiber optic sensors, we at Luna Innovations strongly urge you to ***TAKE CARE OF YOUR CONNECTORS***.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

This page has been intentionally left blank.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

User Interface Software

The FiberPro 2 User Interface Software is a PC-based, menu-driven system that runs under Microsoft® Windows®. To start the software from the Windows® Start Menu, click ***start*** **> All Programs > Luna Innovations > FiberPro2**. Another method for starting the software is to look under **C:\Program Files\Luna Innovations\FiberPro2** and execute the file **FiberPro2.exe** in this folder

Note: The folder **C:\Program files\Luna Innovations\FiberPro2** *is the default folder used in the installation process.*

Once the software is running, instrument control, communication, and data flow are handled via the USB port and are transparent to the user.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Instrument Configuration

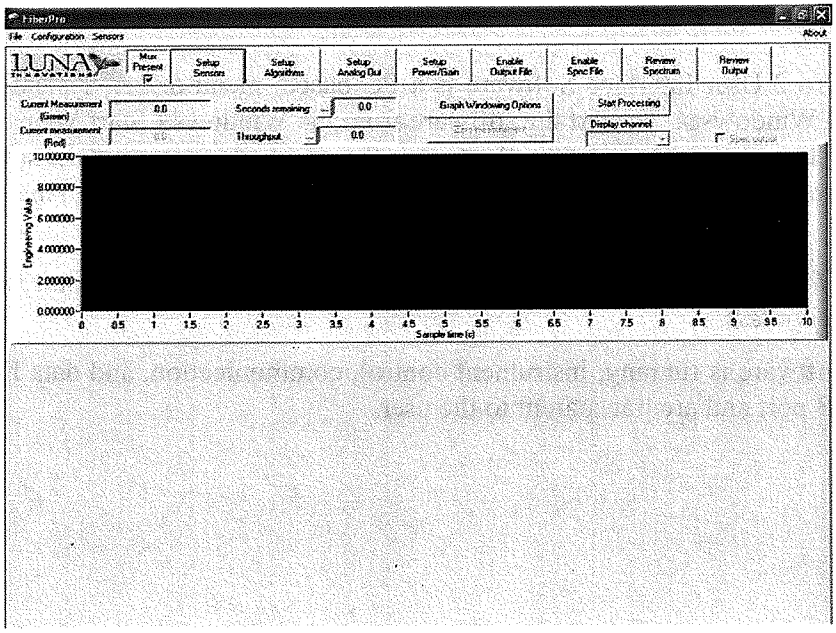


Figure 11. User Interface Software Opening Window.

When the User Interface Software first opens, the user needs to configure some instrument settings before data can be acquired. A sensor must be setup and connected to the FiberPro 2 before instrument configuration can proceed. Please refer to page 39, "Adding a New Sensor" section for instructions on adding a sensor. Once the Sensor is configured the user needs to set the power, gain, and offset. Figures 12, 13, and 14, show the typical un-optimized spectrum for an EFPI sensor, FBG sensor, and an LPG sensor, respectively. The power, gain, and offset menu can be accessed from the User Interface Screen by clicking the Setup Power/Gain button.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

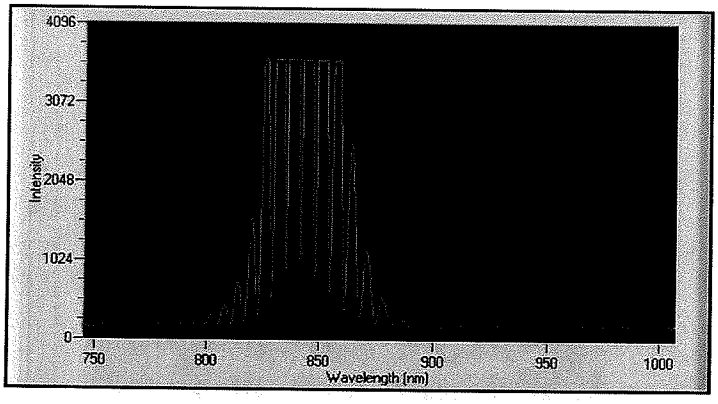


Figure 12. EFPI Spectral Plot Before Instrument Configuration.

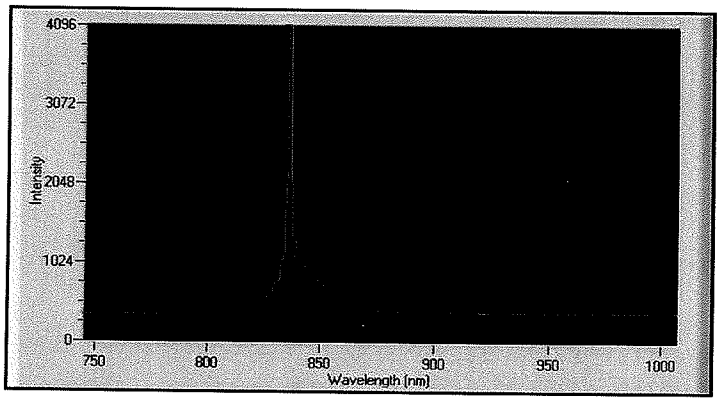


Figure 13. FBG Spectral Plot Before Instrument Configuration.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

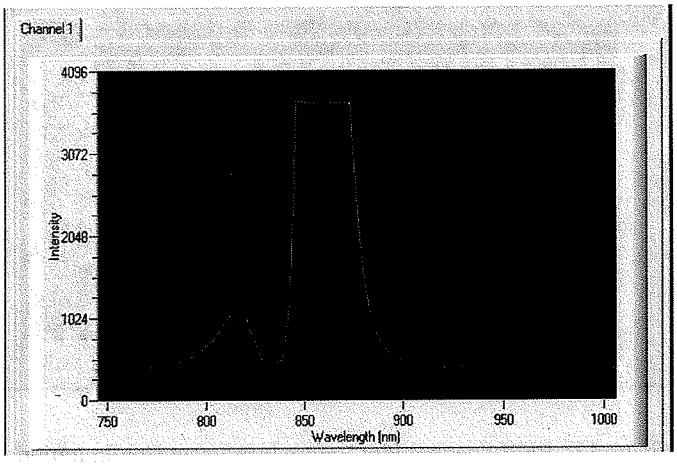


Figure 14. LPG Spectral Plot Before Instrument Configuration.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Configuring the Source and A/D Converter

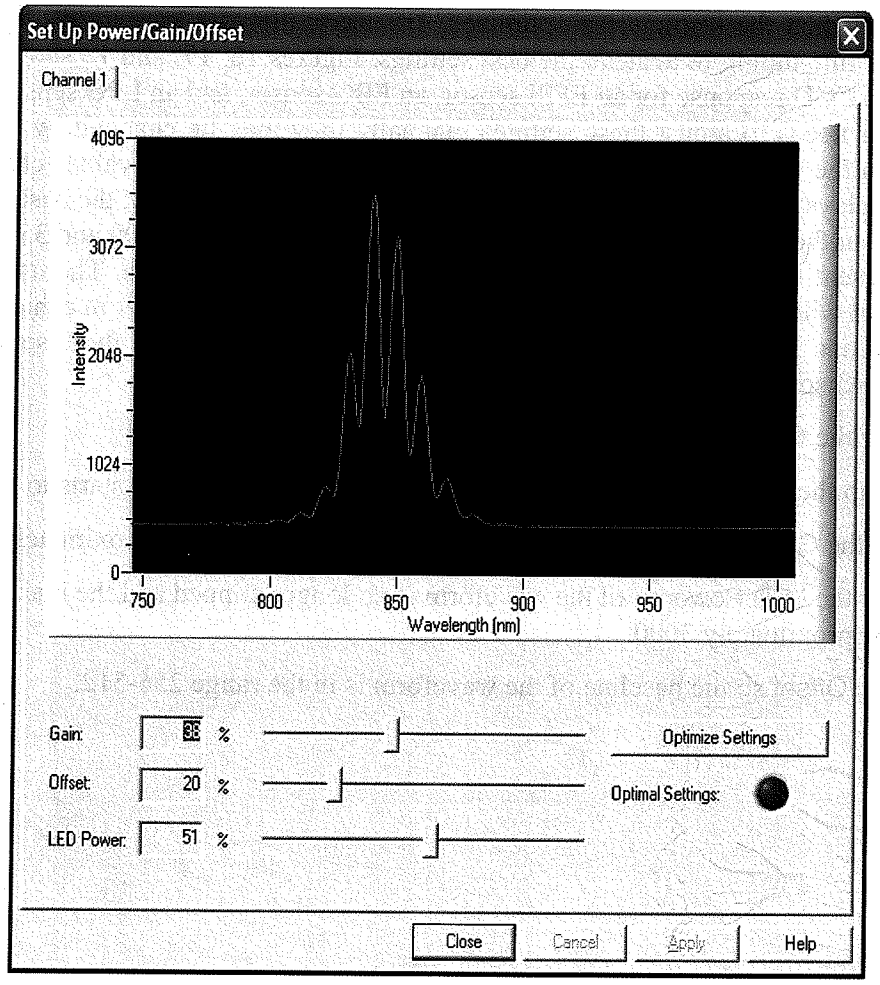


Figure 15. Set Up Power/Gain/Offset Submenu.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Before acquiring data, the power of the light source, and the gain and offset of the A/D converter need to be optimized using the Set Up Power/Gain/Offset submenu, refer to Figure 15. Normally, the settings for Gain, Offset, and LED Power will not be optimal and will need to be adjusted. By selecting the Optimize Settings button. The green light next to the button will illuminate when the settings are optimized. However, the user may need to perform some additional fine tuning to achieve the best settings. Figures 16, 17, and 18 show an optimized plot of the CCD response for an EFPI sensor, an FBG sensor, and an LPG sensor respectively. If the user needs to adjust these settings manually they may be changed by "grabbing" the pointer on the slide bar beside the parameter and moving it. As the values change, the plot, which displays the Intensity of the CCD response, will change. Ideally, the baseline of the plot should be in the range 256-512, and the plot should peak between 3000 and 3500, these numbers represent the Intensity values shown on the Y-Axis of the graph. The user will need to experiment with different settings for the Gain, Offset, and LED Power to achieve the optimal settings. Luna Innovations uses the following procedure to optimize these settings for EFPI and FBG sensors:

1. Lower the Gain to about 1/4 of its full range.
2. Turn up the LED Power until the maximum peak in the waveform starts to 'clip'.
3. Raise the Gain until the clipped portion of the waveform is at approximately 3500.
4. Lower the LED Power until the waveform is no longer clipped and the maximum peak is at approximately 3000.
5. Set the Offset so the baseline of the waveform is in the range 256-512.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

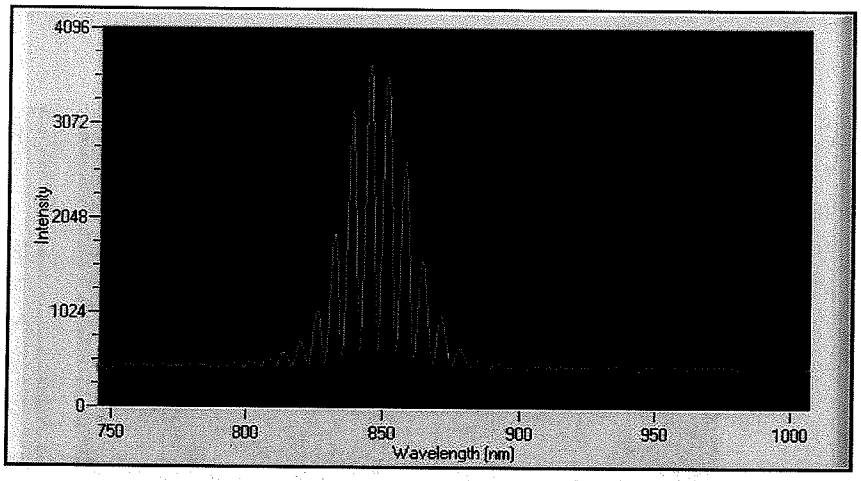


Figure 16. Optimized Plot of the CCD Response for an EFPI Sensor.

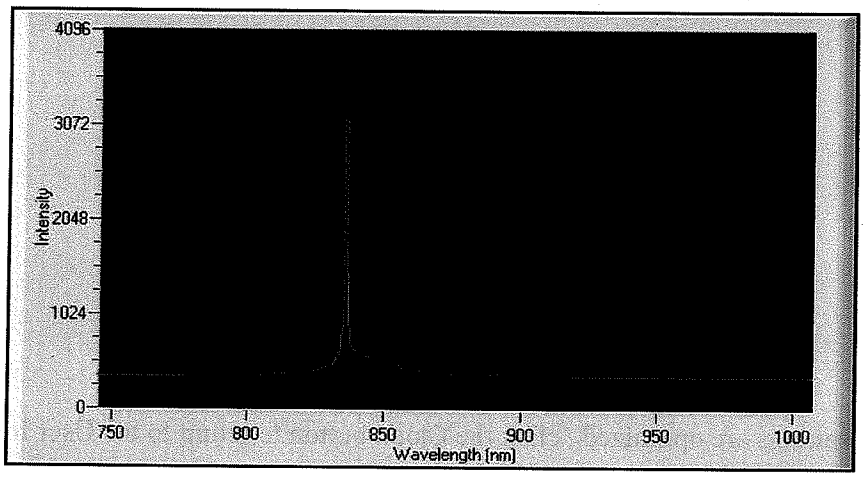


Figure 17. Optimized Plot of the CCD Response for an FBG Sensor.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

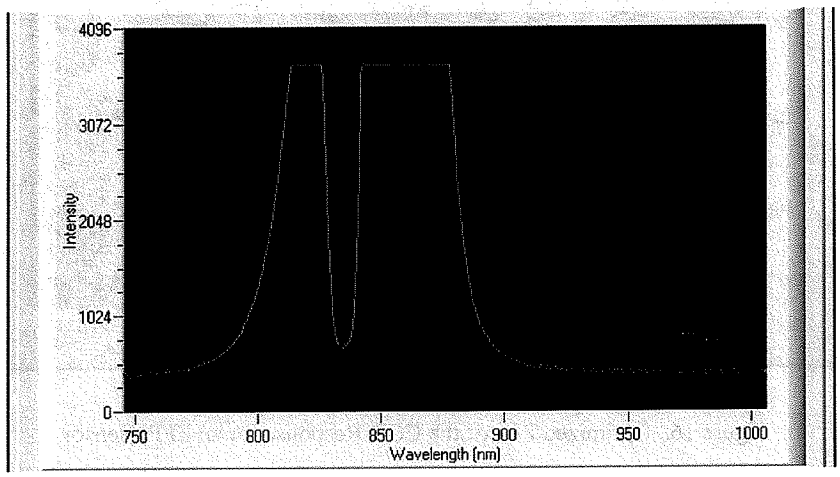


Figure 18. Optimized Plot of the CCD Response for an LPG Sensor.

When the settings are optimized , click the Close button to return to the User Interface Screen.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Analog Output Configuration

The FiberPro 2 instrument provides an analog output port on the rear panel. To configure the analog output, either select Configuration > Set up analog output from the pull down menu or by clicking the Set up analog out button on the User Interface Screen. The submenu shown in Figure 19 will open.

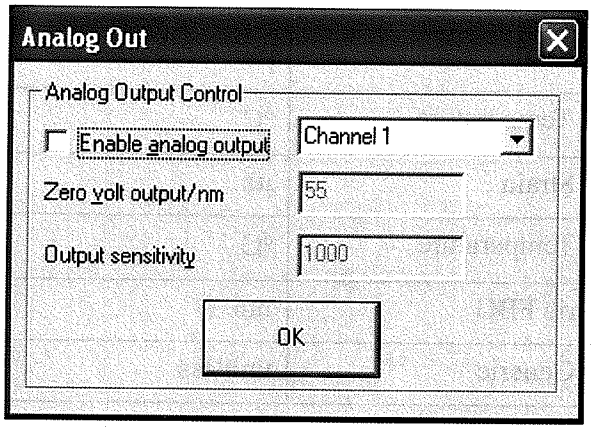


Figure 19. Analog Output Configuration Submenu

To use the analog output feature, the user must first enable analog output in the software. To enable analog output, check the option Enable analog output. To configure the output, enter values for the Zero volt output, (offset), and the Output sensitivity, (scale). The unit for Zero volt output corresponds to the engineering unit of the sensor, °C, for example. The table below lists the engineering units for each type of sensor. The Output sensitivity is expressed in mV/*unit*, where *unit* corresponds to the engineering unit of the sensor. The analog output is capable ±10V, and values that lie outside that range are clipped. Click OK to accept the values entered in the submenu, and return to the User Interface Screen.

Note: The Zero measurement *button on the User Interface Screen does NOT apply to the analog output.*

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Sensor Type	Engineering Unit
EFPI Absolute Gap	μm
EFPI Pressure	psi
EFPI Relative Gap	μm
EFPI Strain	με
EFPI Temperature	°C
FBG Strain	με
FBG Temperature	°C
Generic FBG	nm
LPG Generic	unitless

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

User Interface Screen

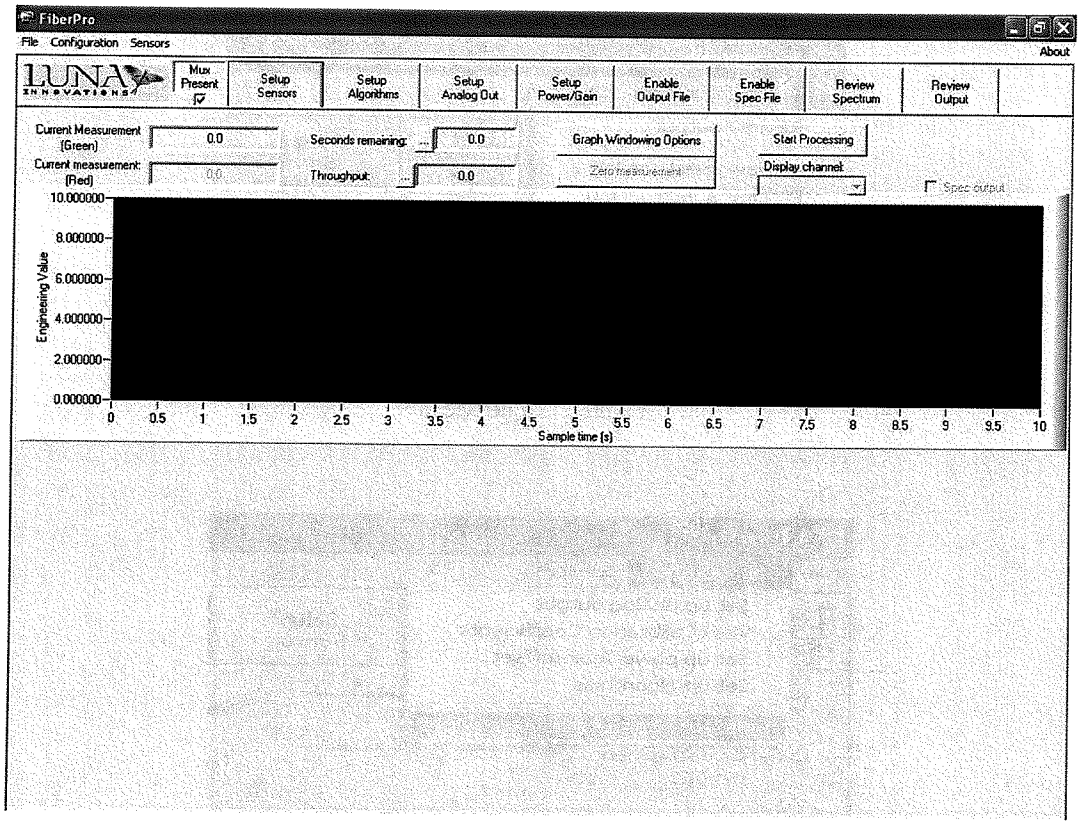


Figure 20. User Interface Screen.

When the User Interface Software first starts, the FiberPro 2 User Interface Screen will open with the default settings shown in Figure 20. Submenus are accessed from the User Interface Screen using two methods: by using the mouse to access the pull-down menus across the top of the User Interface Screen or by selecting the buttons on the User Interface Screen. Figure 20 shows the User Interface Screen without a pull-down menu selected. Figures 21-24 show the File, Configuration, Sensors, and About pull-down menus, respectively. The following

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Sections give a more detailed discussion of each submenu and its options. If the user wants to return to the set-up from the factory, simply select "Restore Defaults" from the Configuration pull down menu.

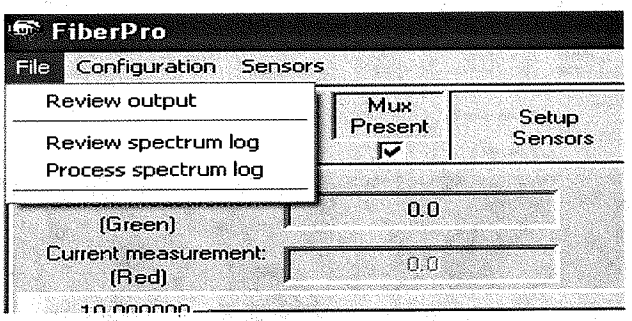


Figure 21. File Menu

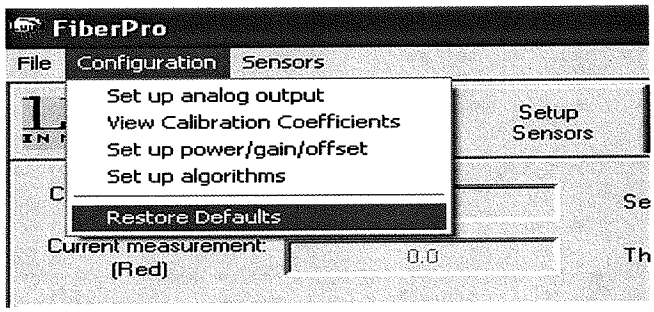


Figure 22. Configuration Menu

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

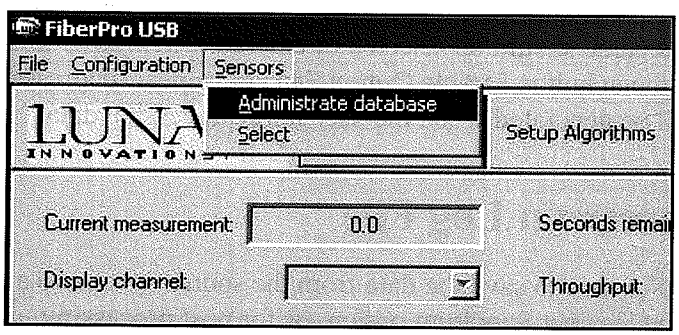


Figure 23. Sensors Menu

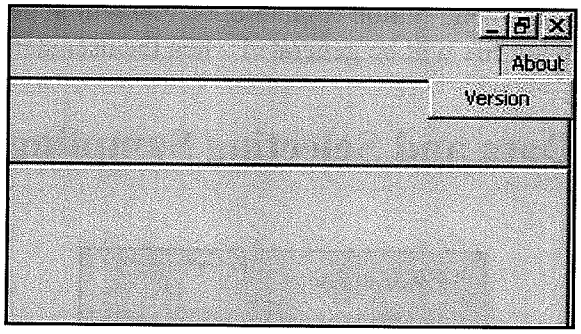


Figure 24. About Menu

Selecting an Output File for Processing

When the Enable Output File feature is used two things happen. The FiberPro 2 software will save an **.out file** that can be viewed using the software and also an ASCII file of the data. The user can view the ASCII file at anytime, even while the software is still processing the sensor information. The user will be prompted to save the two separate files when they choose to enable the output file. To enable this save option and specify the name of the output files, either select File > Set output file for processing from the pull-down menu, or click on the

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

menu button Enable Output File. Two standard file dialog boxes will appear, the desired file folder should be located, and a file name with the extension **.out** should be selected or entered and then a **.txt** file name should be selected or entered. Click Save to complete the file selection process. The menu button Enable Output File will appear 'depressed' which indicates that the output file will be generated when the user starts processing data.

Selecting a Spectrum Log File

The user may also choose to save the data from the source spectra to a log file for review at a later time using the Review Spectrum option, or for post processing using the Process spectrum log option. To enable this save option and specify the name of the log file, either select File > Set spectrum log file from the pull-down menu or click on the menu button Enable Spec File. A standard file dialog box will appear, the desired file folder should be located, and a file name with the extension **.ffd** should be selected or entered. Click Save to complete the file selection process. The menu button Enable Spec File will appear 'depressed' which indicates that the spectrum log file will be generated when the user starts processing data.

Decimating the Data and Selecting Sampling Duration

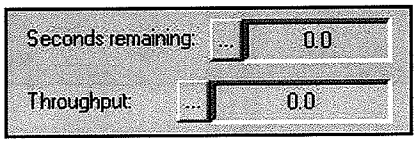


Figure 25. Access to the Sampling Submenus.

Figure 25 shows the area in the User Interface Screen where the Sampling Dialog and Sampling Duration submenus are accessed. Both submenus are accessed by clicking the appropriate ... button.

The output data file can be very large in size. To reduce the size of this file, the user may choose to decimate the data using the Sampling Dialog submenu shown in Figure 26. To access this submenu, the user must click on the ... button to the right of Throughput:. If the

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

user selects the default value of 1 for Logging decimation, the output data will not be decimated. To decimate the data, select a new value from the pull-down list of values for Logging decimation which range from 1/10 to 1/1,000,000. The software will automatically calculate the Logging Rate. Click OK to accept the new value and return to the User Interface Screen.

Note: The values set in the Sampling Dialog submenu only affect the measurement data, they DO NOT affect the spectrum data.

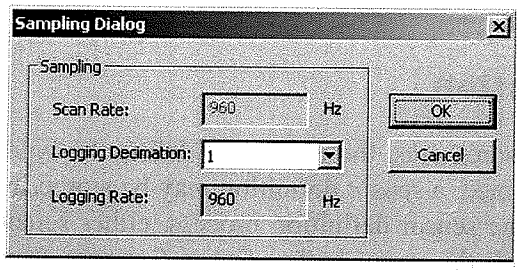


Figure 26. Sampling Dialog Submenu for Decimating the Measurement Data.

The user may choose to capture a fixed time frame of data, or to capture indefinitely until data acquisition is stopped manually by the user. To access the Sampling Duration submenu shown in Figure 27, the user must click on the ... button to the right of Seconds remaining:. The default value is Indefinite, which will produce a continuous stream of data until the user halts processing. To choose a fixed sample duration, deselect Indefinite which will enable access to the Capture Length option. Enter a value in seconds. Click OK to accept the changes and return to the User Interface Screen.

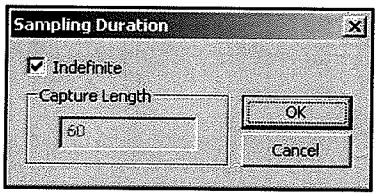


Figure 27. Sampling Duration Submenu for Selecting the Capture Length.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Sensor Configuration and Database Administration

Every sensor used with the FiberPro 2 must be defined, and that definition must be stored in the Sensor Database. The following Sections discuss how to create and store a sensor definition in the Sensor Database, how to manage the Sensor Database, and how to configure the channel for a selected sensor.

4 Sensor Configuration

Before taking any measurements, the user must define the type of sensor to be used in the measurement. Once defined, a sensor definition may be stored in the Sensor Database for use at any time. To begin the sensor definition process, either select Sensors > Select from the pull-down menu or click the menu button Setup Sensors from the User Interface Screen which will open the Sensor Configuration submenu shown in Figure 28. Another path to the Sensor Configuration submenu is through the sensor database administration process which is discussed in the Section "Managing Sensor Definitions" on page 46.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

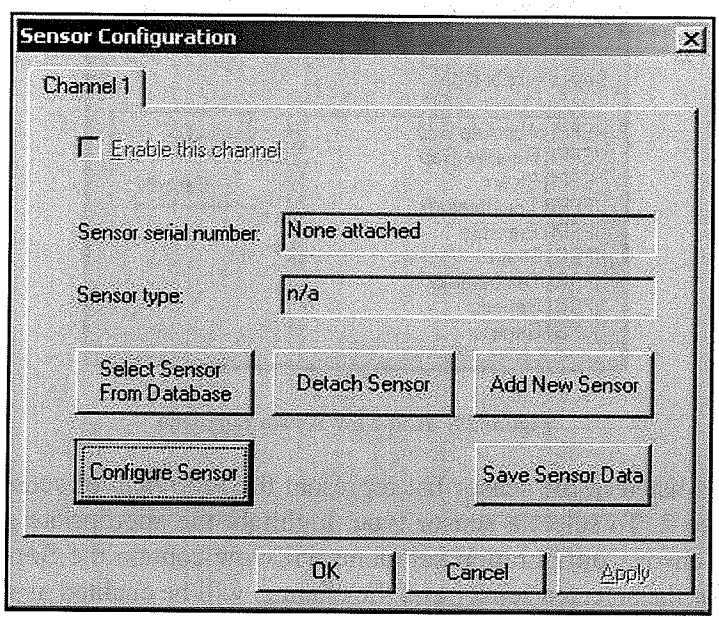


Figure 28. Sensor Configuration Submenu

Initially, the channel will be disabled and no sensor will be defined or attached to the channel. The user may enable the channel and attach a sensor by using the Add New Sensor or Select Sensor From Database options. The Configure Sensor option allows the user to reconfigure a sensor's parameters, and the Save Sensor Data option will save the new sensor configuration in the database. The Detach Sensor option will disable the channel and remove the attached sensor.

Adding a New Sensor

Once in the Sensor Configuration submenu, select the option Add New Sensor to open the Add New Sensor submenu shown in Figure 29.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

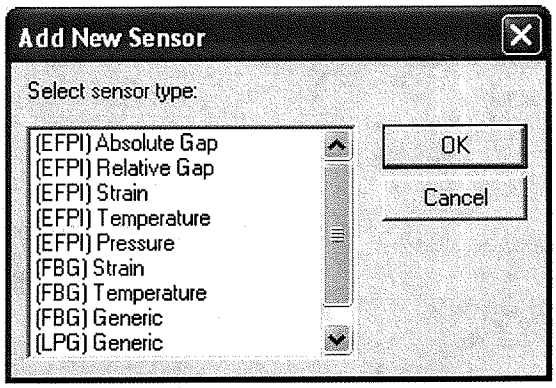


Figure 29. Add New Sensor Submenu

The sensor types listed in the sensor list represent the full range of sensors that may be used with the FiberPro 2. To select a sensor type, highlight the appropriate sensor in the list and click OK. The Sensor Configuration submenu will now contain the Sensor type and Sensor serial number for the selected sensor and the channel will be enabled as shown in Figure 30.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

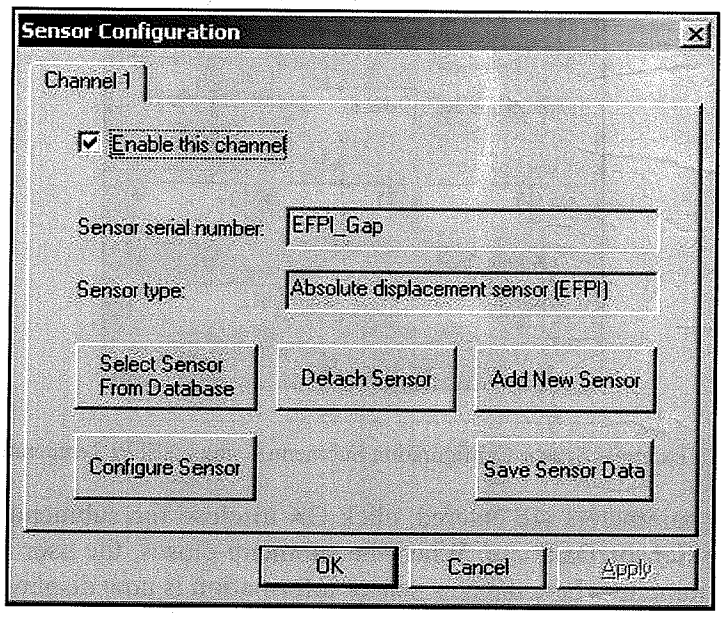


Figure 30. Sensor Configuration Submenu with Sensor Attached and Channel Enabled.

Configuring a Sensor

Once a sensor type is selected, a Configure submenu will automatically open. This submenu will vary with the type of sensor selected. The example in Figure 31 uses an EFPI Temperature sensor. The user will enter the sensor parameters supplied by Luna Innovations with the sensor. This submenu is the same menu that appears when the user selects Configure Sensor from the Sensor Configuration submenu shown in Figure 28. Appendix A shows an example of the Sensor Configuration submenu for every available sensor.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

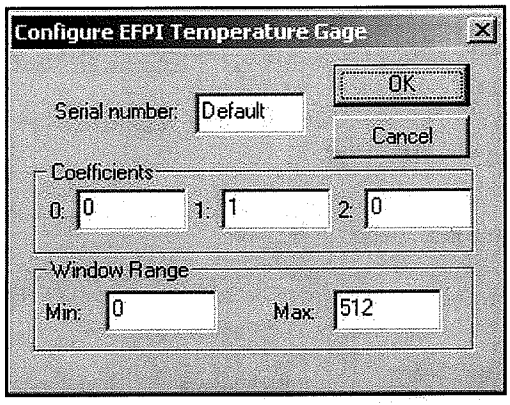


Figure 31. Example Sensor Configuration Submenu Using an EFPI Temperature Sensor

Once all sensor parameters are entered, click OK to close the submenu and save the sensor definition in the Sensor Database. When the submenu closes, the user returns to the Sensor Configuration submenu where the new sensor information is now displayed and the channel is enabled. The user may define additional sensors or click OK to return to the User Interface Screen.

Selecting a Sensor from the Database

Once a sensor definition is created using the Add New Sensor submenu, it permanently resides in the Sensor Database and does not need to be configured again unless its parameters change. To attach a sensor that resides in the database, click on the option Select Sensor from Database in the Sensor Configuration submenu shown in Figure 28. A window containing the complete list of sensors stored in the database, as shown in Figure 32, will open. Click on the Serial number field of the desired sensor to highlight it, and then click Select. Once a sensor is selected, the user returns to the Sensor Configuration submenu where the selected sensor is now displayed and the channel is enabled.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

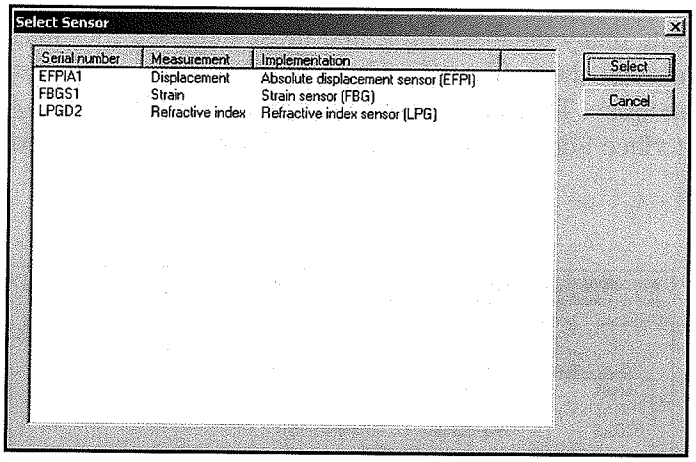


Figure 32. Window for Selecting a Sensor from the Database.

Detaching a Sensor

If the user decides to change the sensor connected to the front panel of the FiberPro 2 instrument, the user must 'detach' the current sensor configuration in the software and enter the new sensor configuration. To remove the old sensor, select Detach Sensor from the Sensor Configuration submenu shown in Figure 28.

Saving the Sensor Database

Once the sensors are configured and stored in the sensor database, the current sensor database needs to be stored in a database file. From the Sensor Configuration submenu shown in Figure 32, select Save Sensor Data to save the current sensor database in a permanent database file. See the Section entitled "Managing Database Files" on page 44 for more discussion on database files.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Sensor Database Administration

The user may create many database files, and those database files may contain many sensor definitions. To manage these files, the User Interface Software includes a set of database administration functions. To access these functions, select Sensors > Administrate database from the User Interface Screen to open the Administrate Sensor Database submenu shown in Figure 33.

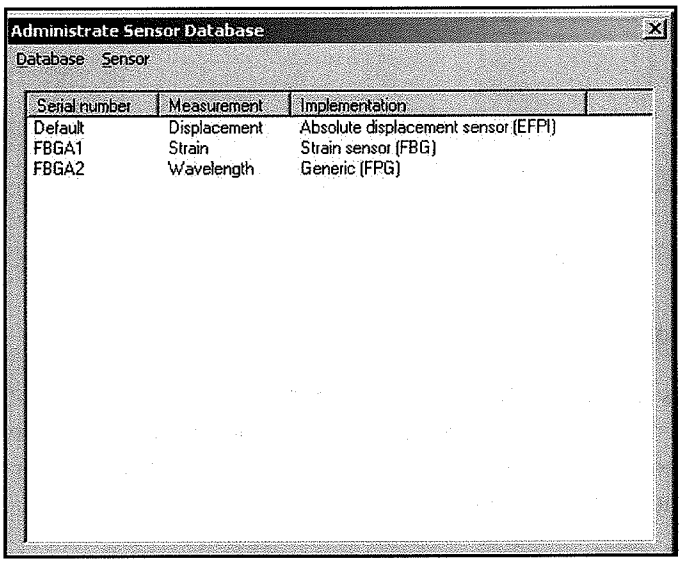


Figure 33. Administrate Sensor Database Submenu

Managing Database Files

The User Interface Software loads a default sensor database file, **Sensors.sns**, at startup if the file exists. To manage and manipulate multiple database files the user will select any of the pull-down menu options shown in Figure 34. To create a new database Database > New. A standard file dialog box will appear. The user will now give the "new" database a name and saving location.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

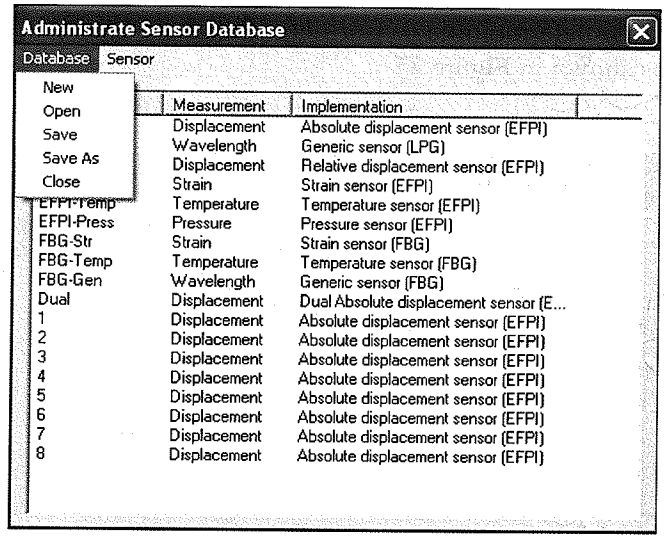


Figure 34. Menu Options for Database Administration.

To load a new database file or merge a new file with the existing database, the user will select Database > Open. A standard file dialog box will appear, and a file name with the extension **.sns** should be selected or entered. If the user chooses to delete the existing database, the program will remove the old database and all of its sensors without saving them. The new database will be loaded with all of its sensors. If the user does not delete the existing database, the new database file and all of its sensors will be merged into the existing database.

To save the current database under the same file name as it was loaded or created, select Database > Save. The program automatically saves the current database to the file **Sensors.sns** in this manner when the user quits the program.

To save the current database under a different file name, select Database > Save As. A standard file dialog box will appear, and a file name with the extension **.sns** should be selected or entered.

To close the current database and clear the sensor list, select Database > Close. Close the Administrate Sensor Database window to return to the User Interface Screen.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Managing Sensor Definitions

To manage and manipulate multiple sensor definitions, the user will select any of the pull-down menu options shown in Figure 35.

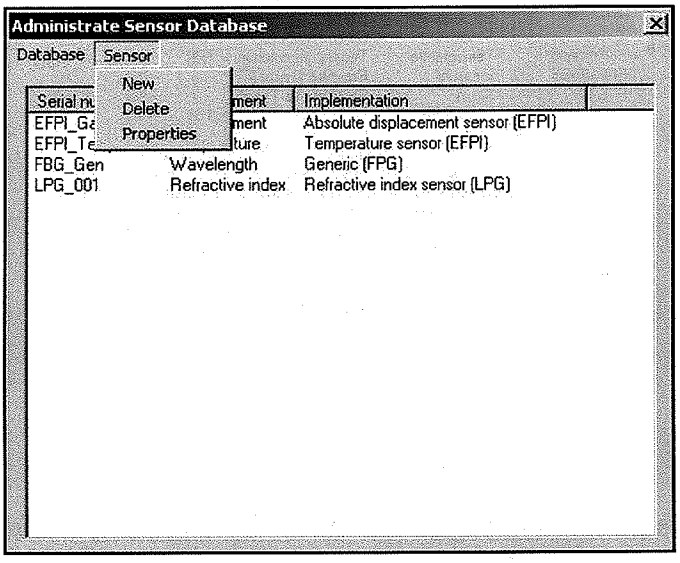


Figure 35. Menu Options for Sensor Management.

The Section entitled "Sensor Configuration" on page 38 discusses the steps for creating a new sensor definition from the User Interface Screen. To begin this process from the Administrate Sensor Database submenu, select Sensor > New and follow the same steps.

The user may also change or delete existing sensor definitions. To change the properties of an existing sensor definition, highlight the appropriate sensor Serial number in the list and select Sensor > Properties. The same Configure submenu used to define the original sensor properties is used to change the sensor properties. The submenu for an EFPI temperature sensor is shown in Figure 36. Refer to Appendix A for a description of the Configure submenu for each type of sensor. The user will enter the new sensor properties, and click OK to update the sensor definition in the database.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

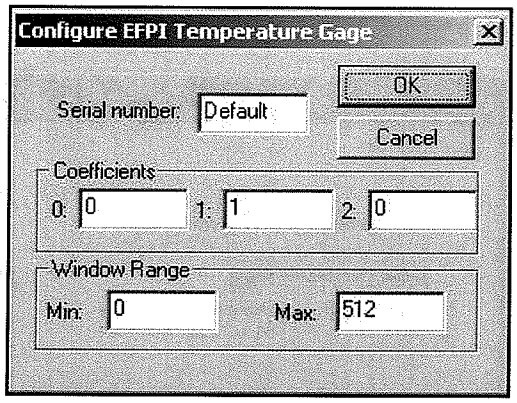


Figure 36. Sensor Configuration Submenu for an EFPI Temperature Sensor

To delete a sensor definition from a database file, highlight the appropriate sensor in the list and select Sensor > Delete.

Sensor Algorithm Configuration

Once the sensors are defined and stored in the Sensor Database, the user must select the appropriate sensor from the database, 'attach' the sensor to enable the channel, and configure the correct algorithm to use in the measurement.

Once the proper sensor is selected and the channel is enabled, algorithm configuration may be required based on the type of sensor selected. To begin this process either select Configuration > Set up algorithms or click the button Setup Algorithms from the User Interface Screen. One of three different submenus will appear based on the type of sensor. The following Sections discuss the algorithm configuration for each type of sensor supported by the FiberPro 2 instrument.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

EFPI Algorithm Configuration

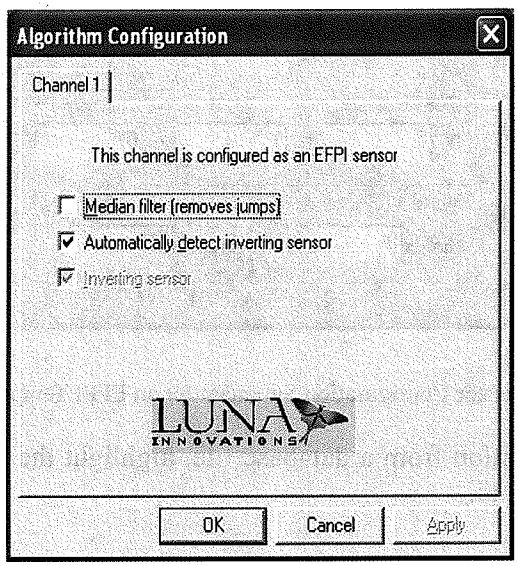


Figure 37. Algorithm Configuration Submenu for an EFPI.

Figure 37 shows the Algorithm Configuration submenu for an EFPI sensor. The user may select any of the data manipulation algorithms provided by checking the box next to the desired type of algorithm. The following Section explains these algorithms. Click Apply to accept the selections, or click OK to accept the selections and return to the User Interface Screen.

Algorithm Configuration for Best Accuracy

The Median filter algorithm utilizes a running seven-point filter to detect infrequent spikes in the data and removes those spikes from the output data. Some sensors, referred to as *inverting sensors*, require a slightly different sensor gap calculation within the software. If the option Automatically detect inverting sensor is selected, the software will determine if the sensor is an inverting sensor and use the correct calculation method. The option Inverting sensor is not

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

available when Automatically detect inverting sensor is selected. However, if the automatic option is not selected, the Inverting sensor option will be active.

The software assumes that the gap on an EFPI sensor is within the range of 15-160 microns.

Note: For the EFPI Algorithm Configuration, Luna Innovations recommends always selecting Automatically detect inverting sensor.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

FBG Algorithm Configuration

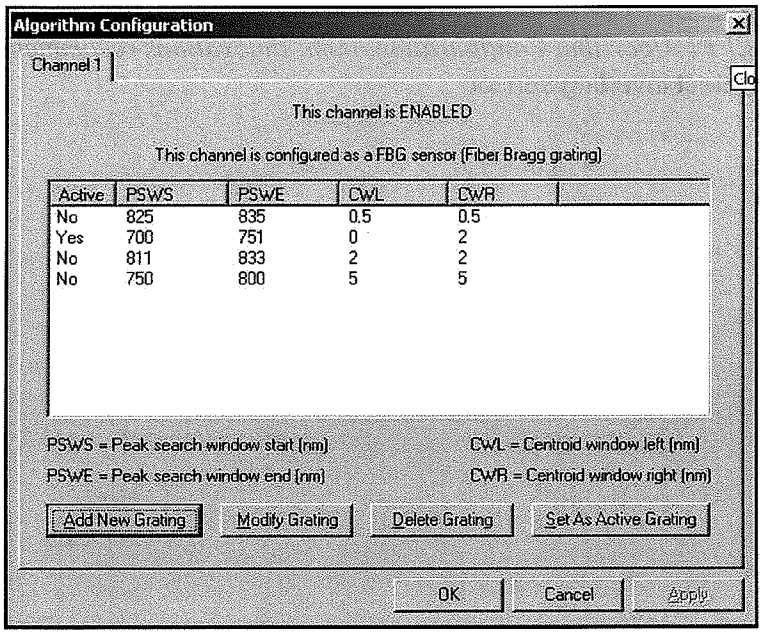


Figure 38. Algorithm Configuration Submenu for an FBG Sensor.

Figure 38 shows the Algorithm Configuration submenu for an FBG sensor. The first column in the window indicates whether a grating is selected as the Active grating. The remaining columns list the parameters set for each grating. One fiber may contain multiple gratings, or sensors, which may be configured and stored for later use. It is important to note that even though an FBG may contain multiple sensors on one fiber, only one grating can be read at a time.

To add a new grating and define its parameters, click the menu button Add New Grating to open the Add New Grating submenu shown in Figure 39. Enter the parameters for the new grating, and click Add. The new grating will appear in the grating list, but will not be active.

Notes:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP